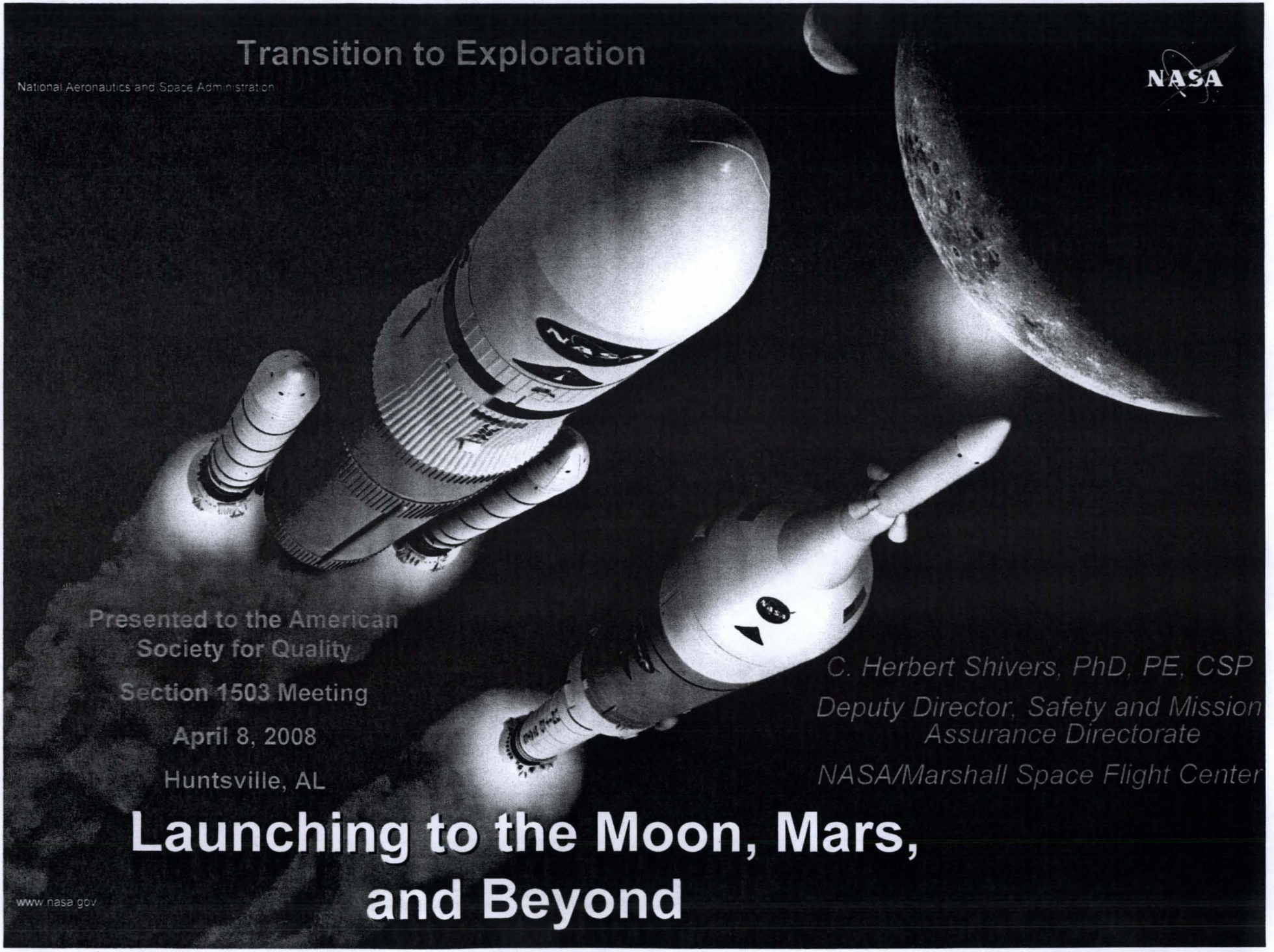
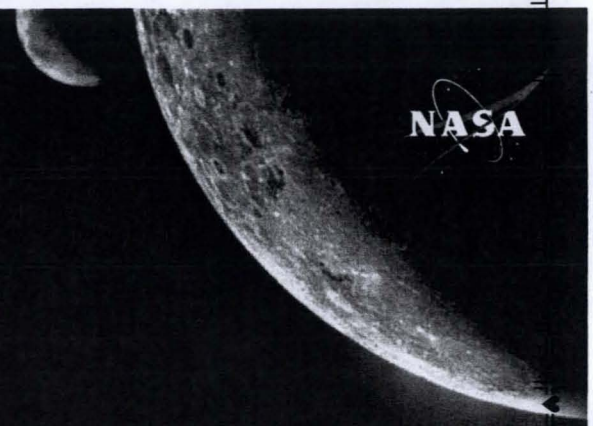
MSFC-772


Transition to Exploration
National Aeronautics and Space Administration
NASA
Presented to the American Society for Quality
Section 1503 Meeting
April 8, 2008
Huntsville, AL
C. Herbert Shivers, PhD, PE, CSP
Deputy Director, Safety and Mission Assurance Directorate
NASA/Marshall Space Flight Center
Launching to the Moon, Mars, and Beyond
www.nasa.gov

MSFC LEGACY

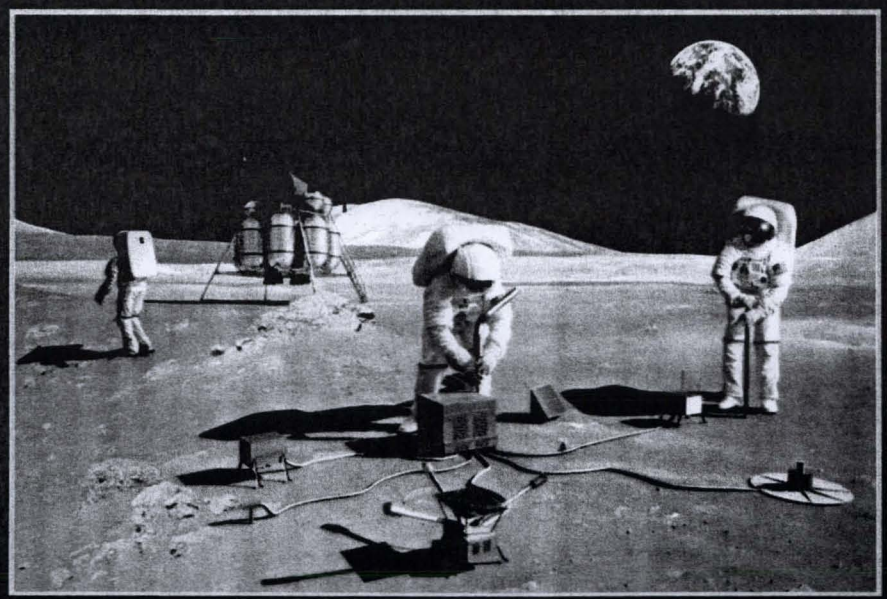


Today's Journey

- What is NASA's mission?
- Why do we explore?
- What is our timeline?
- Why the Moon first?
- What will the vehicles look like?
- What progress have we made?
- Who will be doing the work?
- What are the benefits of space exploration?

What is NASA's Mission?

- Safely fly the Space Shuttle until 2010
- Complete the International Space Station
- Develop a balanced program of science, exploration, and aeronautics
- Develop and fly the Orion Crew Exploration Vehicle (CEV)
- Return to the Moon no later than 2020
- Promote international and commercial participation in exploration



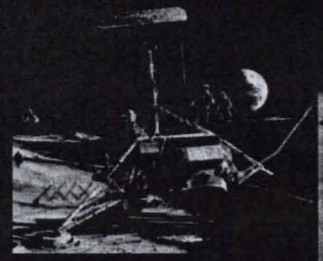
"The next steps in returning to the Moon and moving onward to Mars, the near-Earth asteroids, and beyond, are crucial in deciding the course of future space exploration. We must understand that these steps are incremental, cumulative, and incredibly powerful in their ultimate effect."

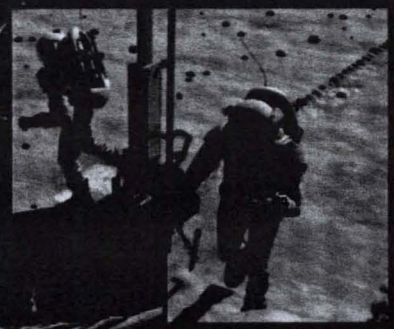
– NASA Administrator Michael Griffin
October 24, 2006

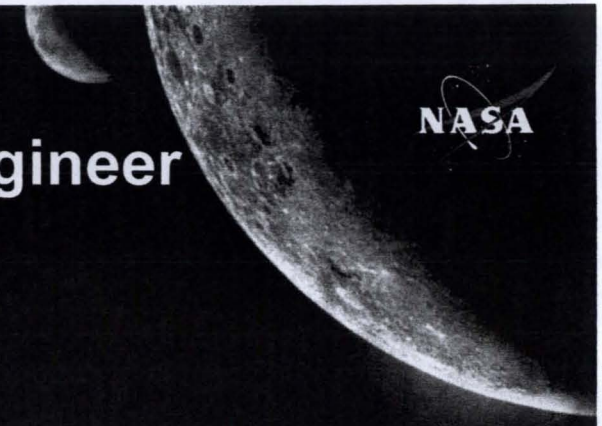
Why Do We Explore?

NASA

- **Inspiration**
  - Inspire students to explore, learn, contribute to our nation's economic competitiveness, and build a better future
- **Innovation**
  - Provide opportunities to develop new technologies, new jobs, and new markets
- **Discovery**
  - Discover new information about ourselves, our world, and how to manage and protect it







Characteristics of a Good Quality Engineer

- Technically credible
- Courageous and full of integrity
- Solid knowledge of technical requirements and tools
- Above average communication skills (verbal & written)
- Experienced in design, manufacturing, T&E and sustaining operations
- Humble yet not reserved
- Persistent yet pragmatic
- Energetic and creative ("yes if")
- *Skeptical but not cynical*
- Thick skinned with a sense of humor (for longevity)

Bryan O'Connor, Chief, Safety and Mission Assurance, NASA, CQSDI, Cape Canaveral
March 2008

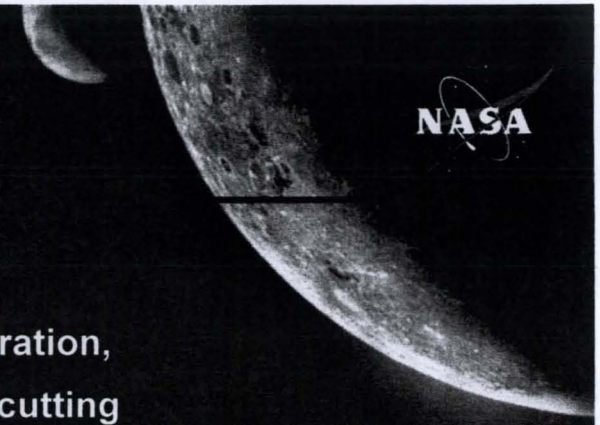
What's on My Mind?

- **Transition from Shuttle to Ares**
  - Planning for Ares testing
    - Integrated vehicle ground vibration
    - Main propulsion test article
    - Cryo-structural testing for Upper Stage
  - Lunar and Other
    - Methane engine research and testing
    - In-space propellant storage
- **Sustaining Shuttle Elements**
  - Manufacturing Quality Assurance
  - Component testing
  - NDE
  - Welding Inspection

Chris Shepherd, Interview in The Marshall Star, March 27,2008

Business phasing out as we/they know it
Job future versus vigilance
Keeping our eyes on the ball

Integrated Probabilistic Analysis Environment (IPAE)



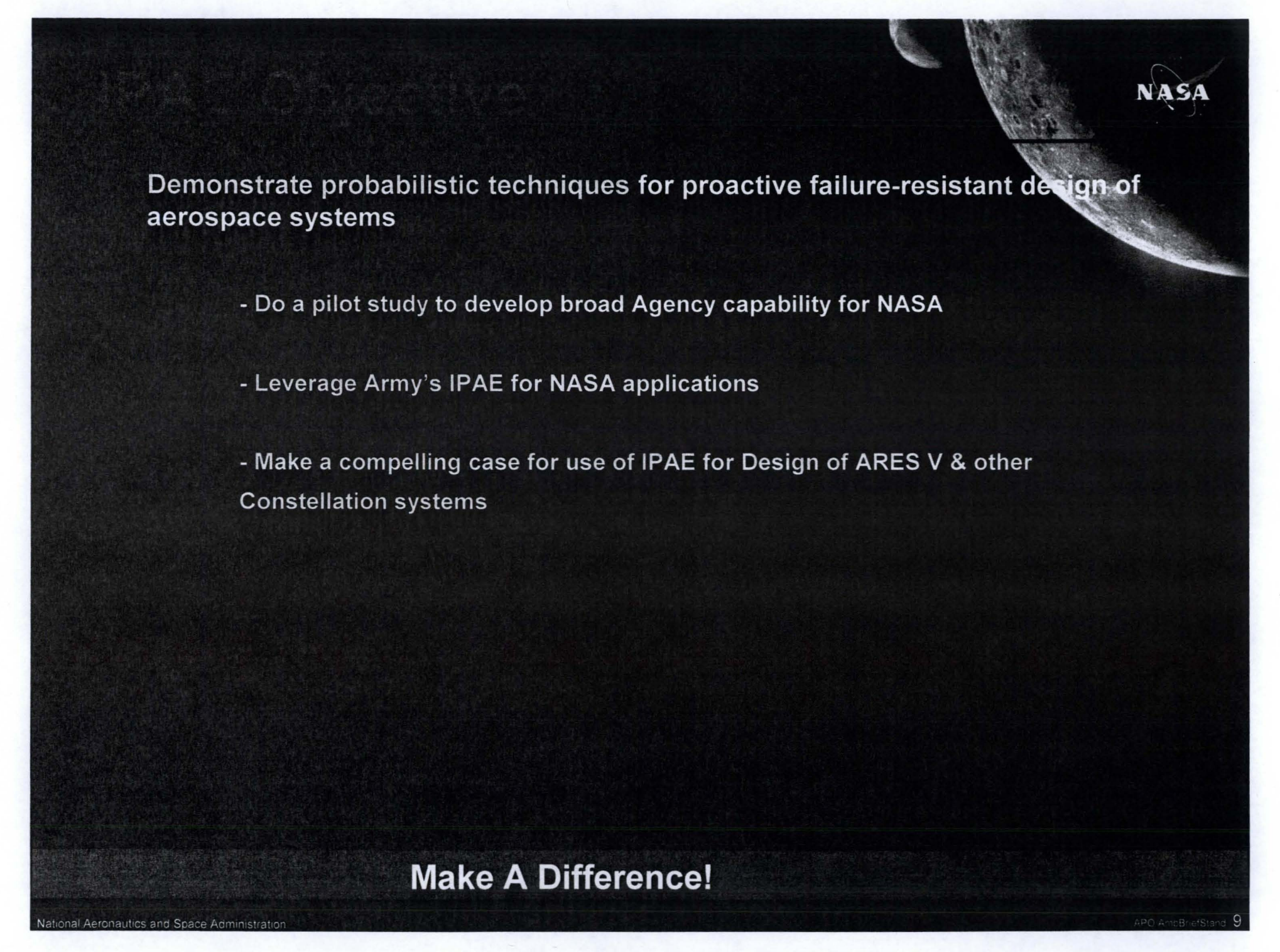
SCOPE

Advance the capability to develop, design, and operate NASA exploration, space operations, science, and aeronautic research systems using cutting edge tools capable of modeling uncertainties

An opportunity to show clear advantage of applications of Physics-based probabilistic analysis methods.

Example: Mass saving

Convert this Technical Excellence Opportunity into Future Capability!



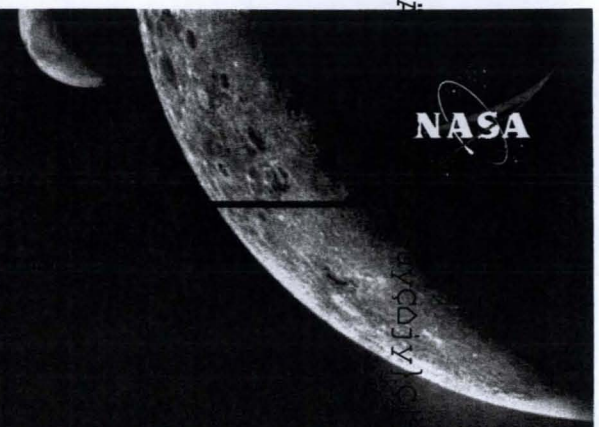
Demonstrate probabilistic techniques for proactive failure-resistant design of aerospace systems

- Do a pilot study to develop broad Agency capability for NASA

- Leverage Army's IPAE for NASA applications

- Make a compelling case for use of IPAE for Design of ARES V & other Constellation systems

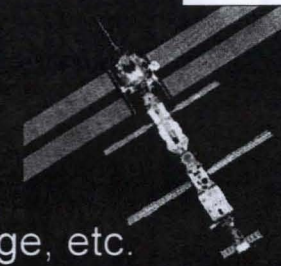
Make A Difference!

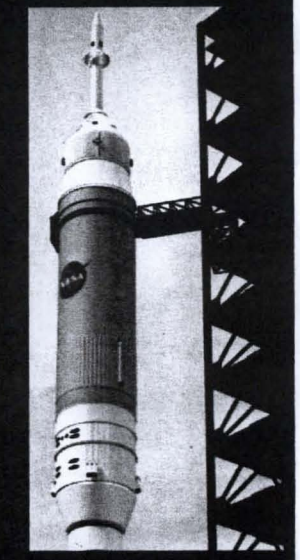


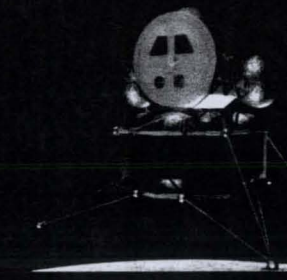
- NASA
  - **MSFC** - Lead center
  - **Other NASA (LaRC, KSC, GSFC, HQ, NESC)**
- Army & Partners
- Academia
  - Perform peer reviews
- Industry
- Ad-hoc Advisors
  - Provide senior executive guidance & broad perspective

Team Members have a stake and are actively involved!!

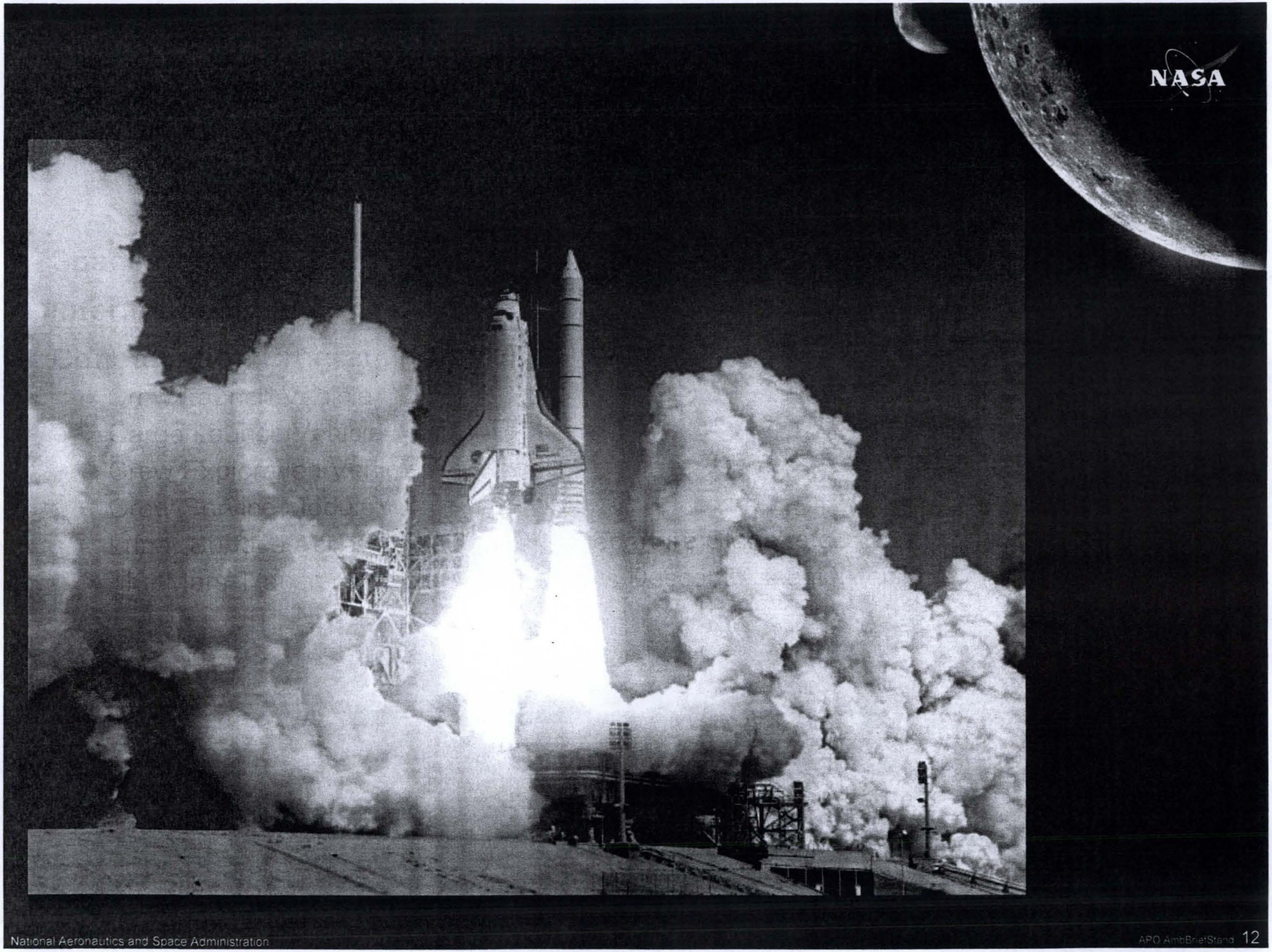
MAJOR NASA PROGRAMS

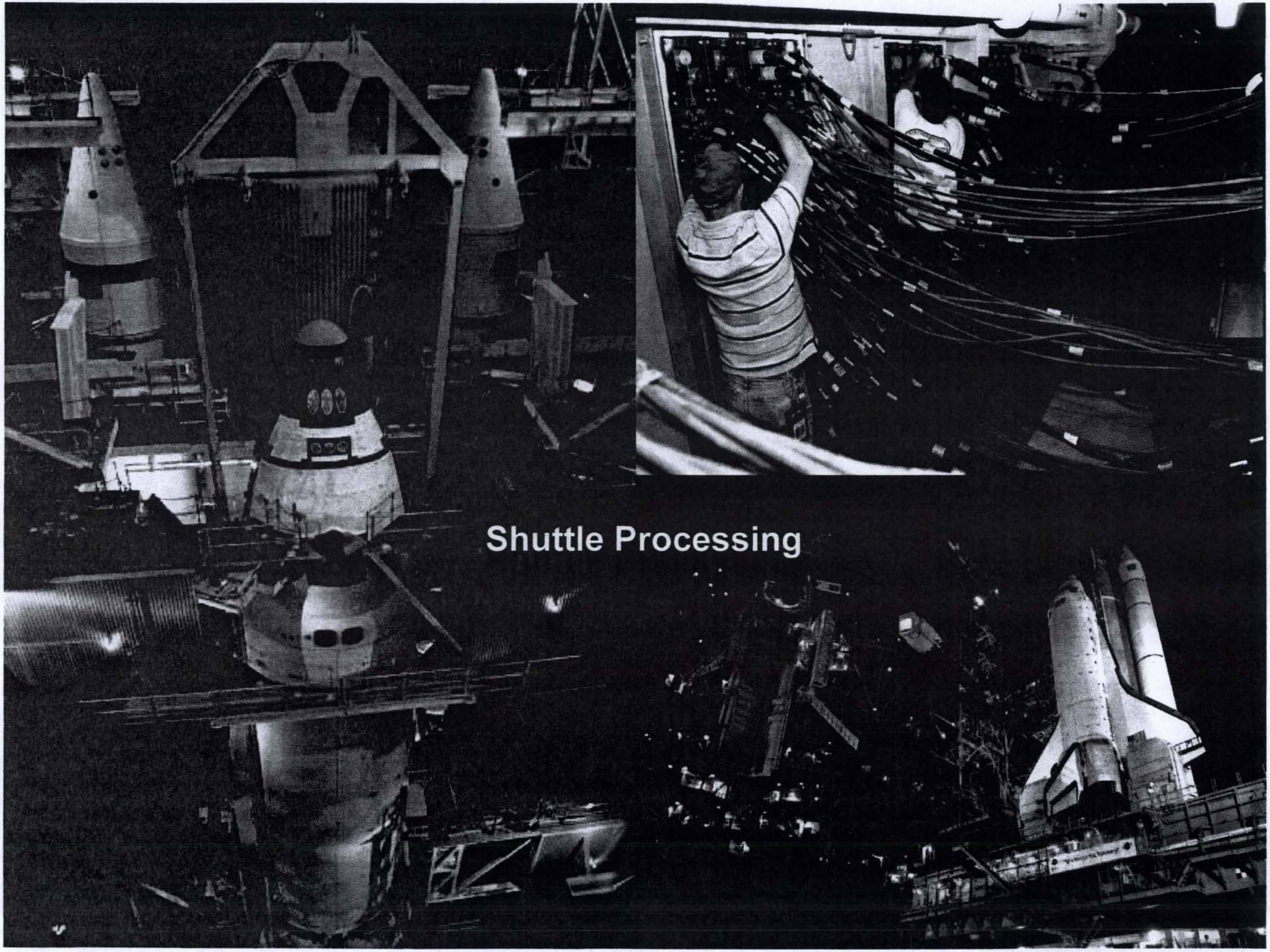




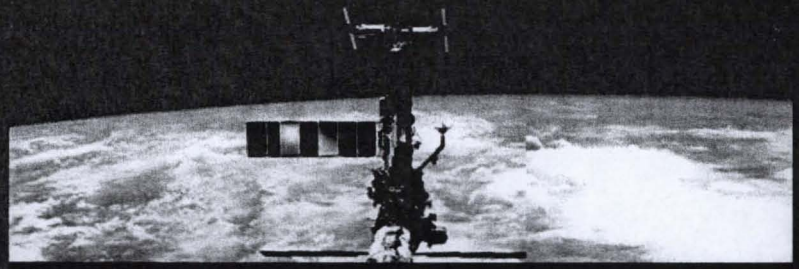


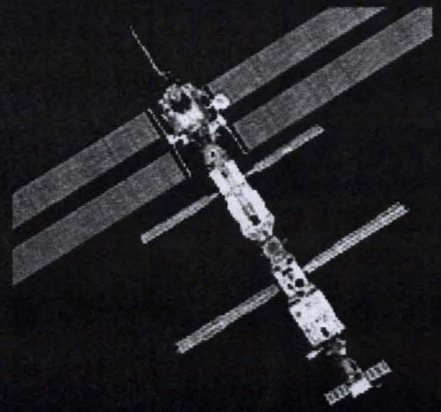
- **Space Shuttle**
- **International Space Station**
- **Constellation Program (Future)**
  - Crew Launch Vehicle
  - Cargo Launch Vehicle
  - Crew Exploration Vehicle
  - Crew Service Module
  - Lunar Surface Access Module, Earth Departure Stage, etc.
  - The Mars Transfer Vehicle and The Mars Descent Ascent Vehicle

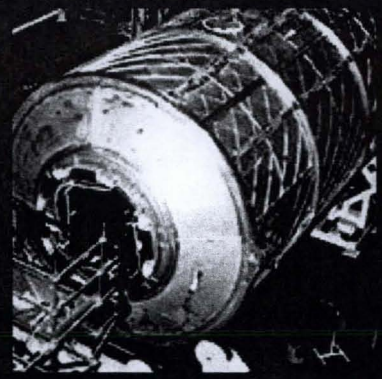

NASA


Shuttle Processing

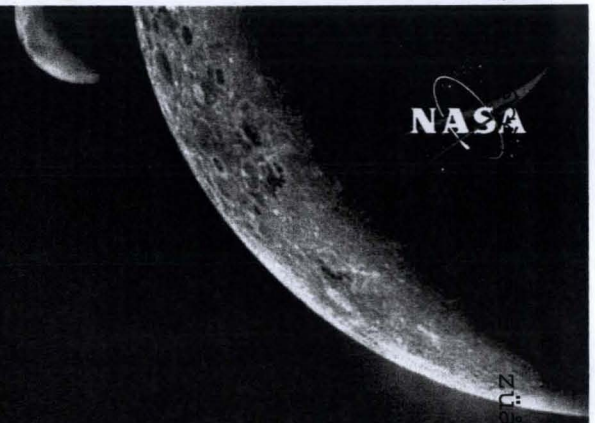
International Space Station







ISS Assembly Sequence



NASA's Exploration Roadmap

What is our timeline?

05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25...

Initial Capability Orion (CEV)

Mars Expedition 2030(?)

Lunar Robotic Missions

Lunar Outpost Buildup

Commercial Crew/Cargo for ISS

Space Shuttle Operations

SSP Transition

Ares I Development

Orion Development

Ares I-X Test Flight April 2009

Orion Production and Operation

Lunar Lander Development

Ares V & Earth Departure Stage

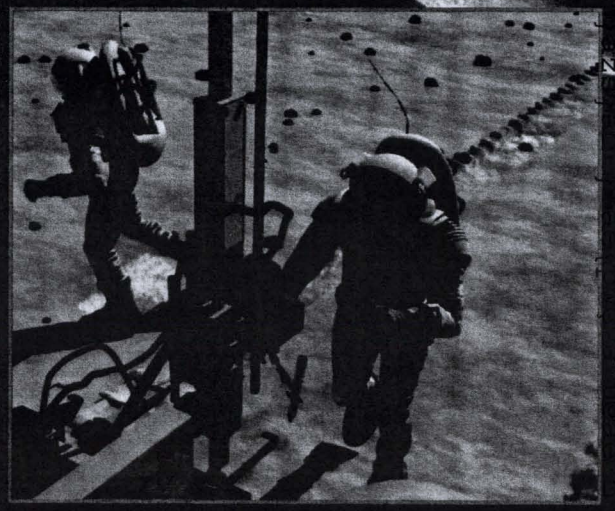
Surface Systems Development

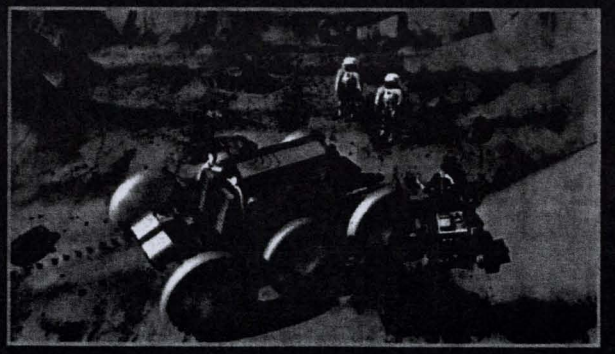
092507

The Moon
The First Step to Mars and Beyond

NASA

- **Lunar missions allow us to:**
  - Gain exploration experience
    - Space no longer a short-term destination
    - Will test human support systems
    - Use Moon to prove ability to build and repair long-duration space assets
  - Develop exploration technologies
    - Launch and exploration vehicles
    - *In-situ* resource utilization
    - Power and robotic systems
  - Conduct fundamental science
    - Astronomy, physics, astrobiology, geology, exobiology





Next Step in Fulfilling Our Destiny as Explorers

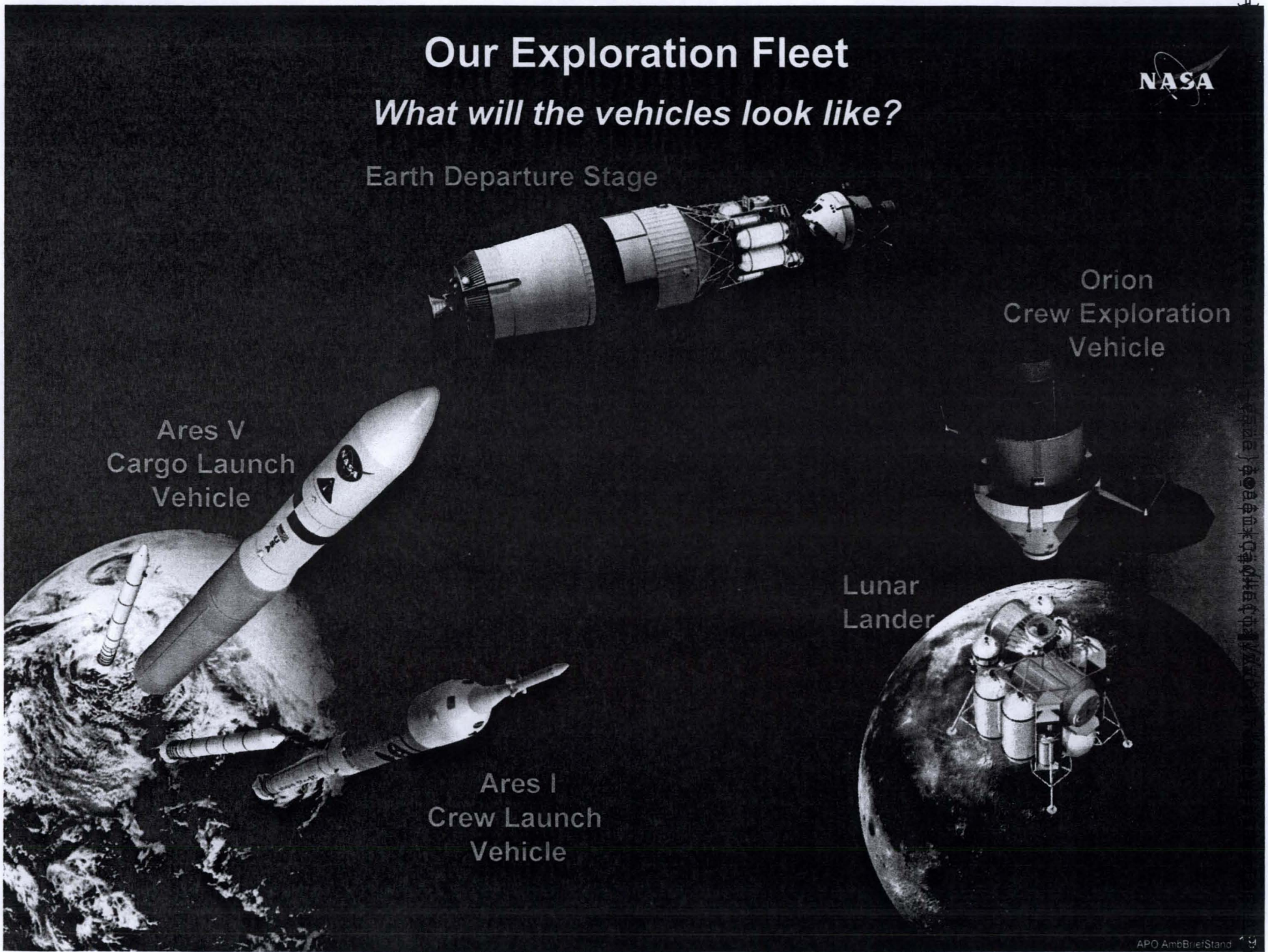
There Are Many Places To Explore

Why the Moon first?

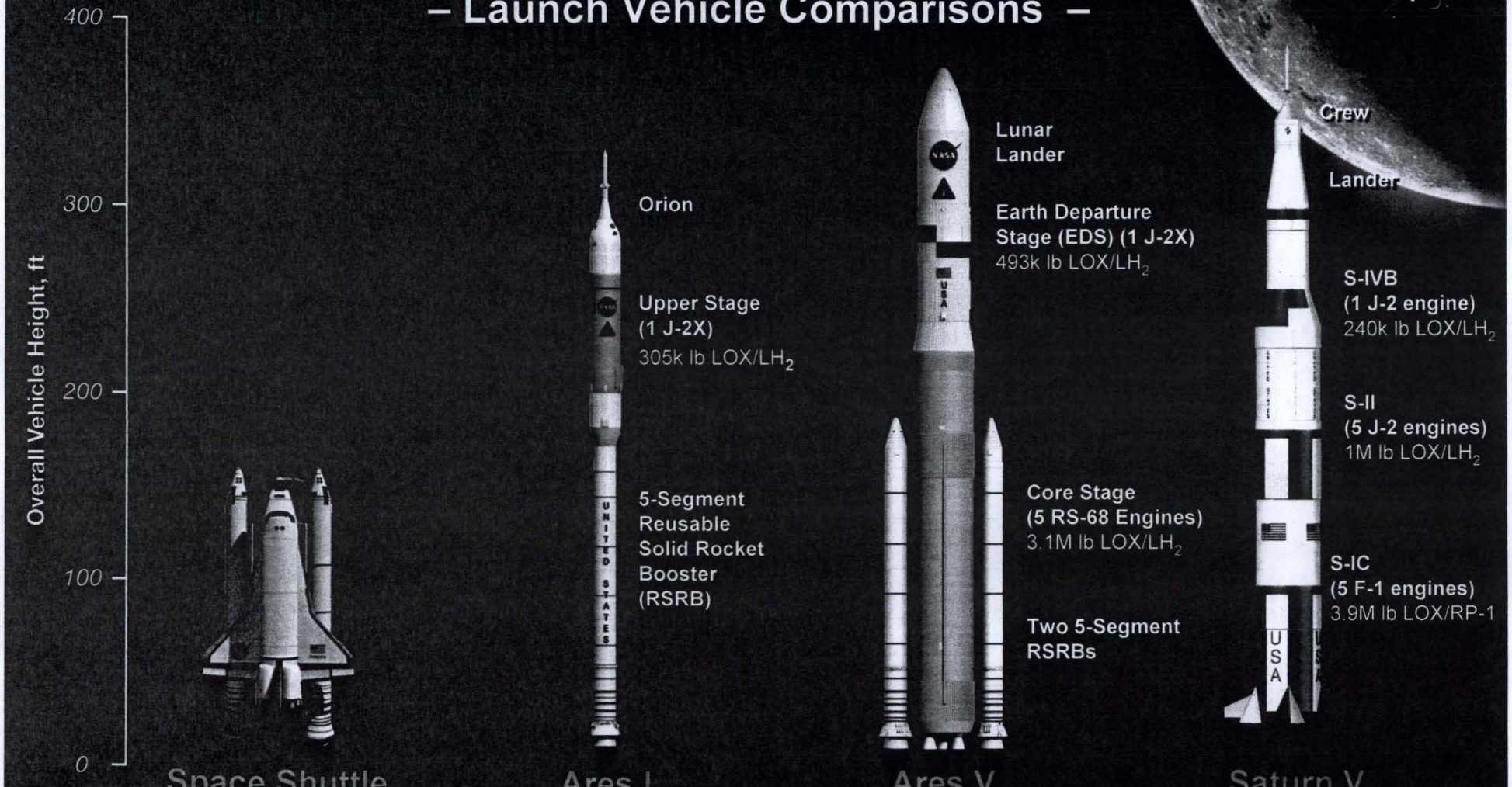
We Can Land Anywhere on the Moon!

Our Exploration Fleet

What will the vehicles look like?



Building on a Foundation of Proven Technologies
– Launch Vehicle Comparisons –



Height: 184.2 ft
Gross Liftoff Mass: 4.5M lb

55k lbm to LEO

Height: 325 ft
Gross Liftoff Mass: 2.0M lb

52k lbm to LEO

Height: 362 ft
Gross Liftoff Mass: 7.3M lb

143k lbm to TLI in Dual-Launch Mode with Ares I
284k lbm to LEO

Height: 364 ft
Gross Liftoff Mass: 6.5M lb

99k lbm to TLI
262k lbm to LEO

Ares I Elements

NASA

Instrument Unit

- Primary Ares I control avionics system
- ***NASA Design*** / *Boeing Production*

Stack Integration

- 2M lb gross liftoff weight
- 325 ft in length
- ***NASA-led***

First Stage

- Derived from current Shuttle RSRM/B
- Five segments/Polybutadiene Acrylonitride (PBAN) propellant
- Recoverable
- New forward adapter
- Avionics upgrades
- *ATK Launch Systems*

Upper Stage

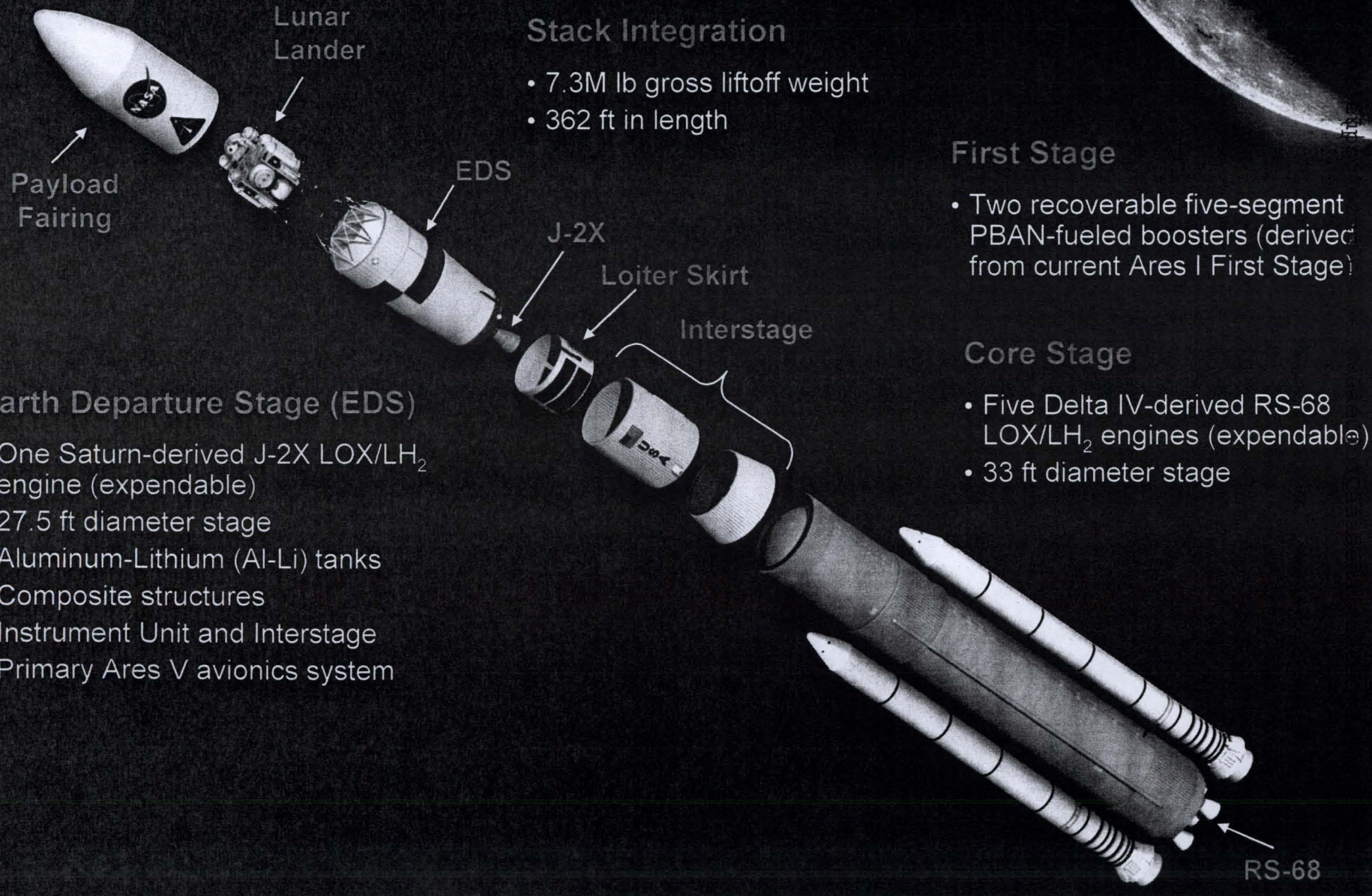
- 305k lb LOX/LH_2 stage
- 18 ft diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument Unit and Interstage
- Reaction Control System (RCS) / roll control for first stage flight
- Primary Ares I control avionics system
- ***NASA Design*** / *Boeing Production*

Interstage

Upper Stage Engine

- Saturn J-2 derived engine (J-2X)
- Expendable
- *Pratt and Whitney Rocketdyne*

Ares V Elements



Stack Integration

- 7.3M lb gross liftoff weight
- 362 ft in length

First Stage

- Two recoverable five-segment PBAN-fueled boosters (derived from current Ares I First Stage)

Core Stage

- Five Delta IV-derived RS-68 LOX/LH_2 engines (expendable)
- 33 ft diameter stage

Earth Departure Stage (EDS)

- One Saturn-derived J-2X LOX/LH_2 engine (expendable)
- 27.5 ft diameter stage
- Aluminum-Lithium (Al-Li) tanks
- Composite structures
- Instrument Unit and Interstage
- Primary Ares V avionics system

Journey to the Moon

What progress have we made?

NASA

- **Programmatic Milestones**
  - Completed Ares I System Requirements and Design Reviews
  - Contracts awarded for building First Stage, J-2X Engine, Upper Stage and Orion
  - Ares I Preliminary Design Review preparations in progress
  - Ares I-X test flight scheduled for April 2009

Ares Progress Recap
2006 - 2007

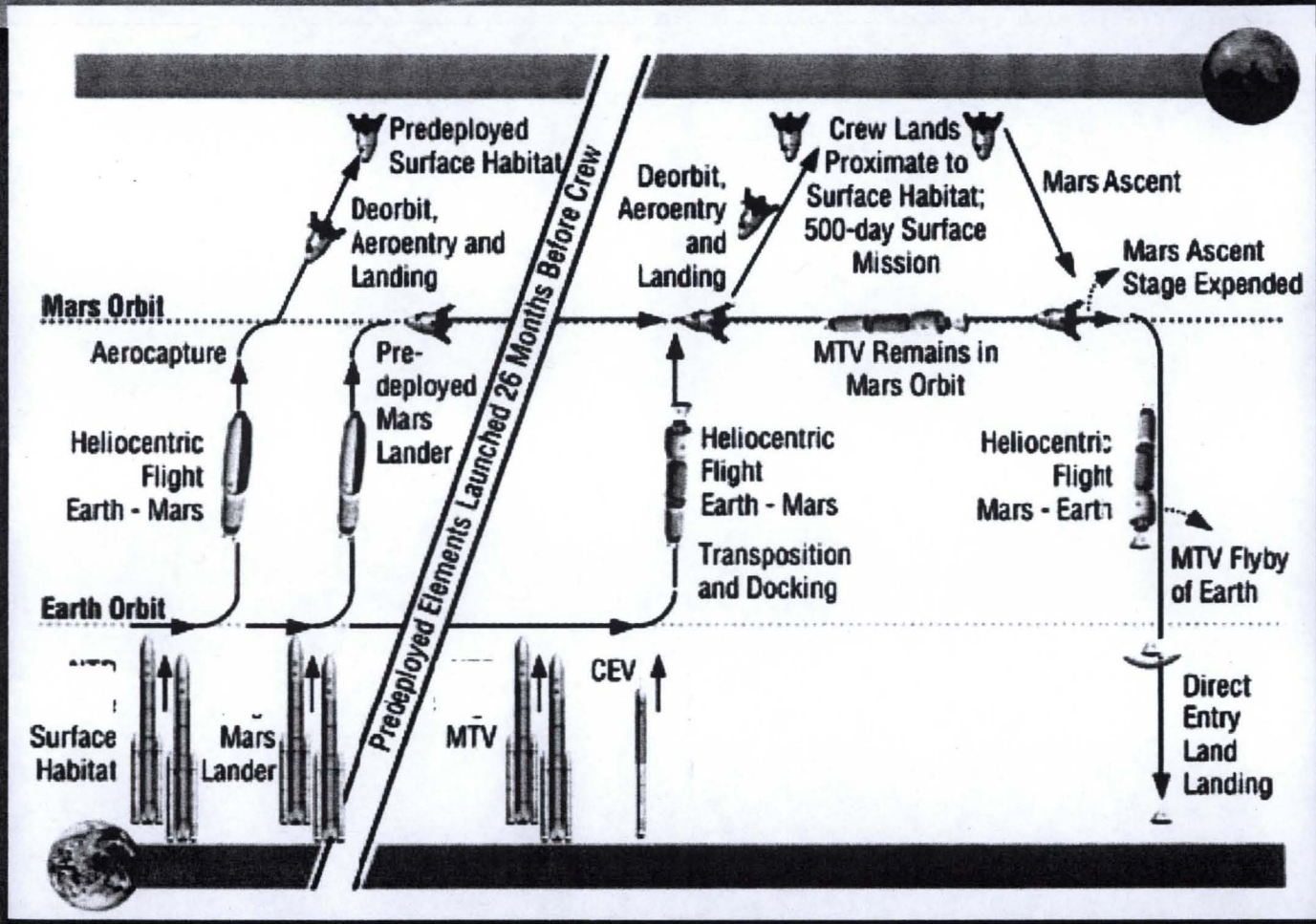
- **Technical Accomplishments**
  - Testing First Stage parachutes and developing nozzles
  - Constructing new J-2X test stand at Stennis Space Center
  - Performing J-2X injector tests and power pack tests
  - Conducting Upper Stage initial Design Analysis Cycle
  - Fabricating Ares I-X hardware
  - Testing in wind tunnels

For more information go to
www.nasa.gov/ares

Ares Nationwide Team

Who will be doing the work?

Concept - MARS Mission



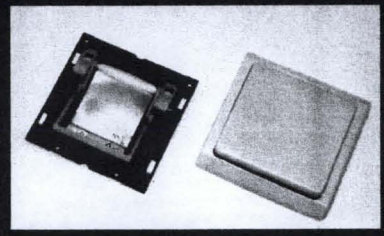
Transfer to and from Mars in about 6 months – Mars surface stay about 18 months. Each human mission to Mars is comprised of three vehicle sets, two cargo vehicles, and one round-trip piloted vehicle. Planned 2.5-year mission

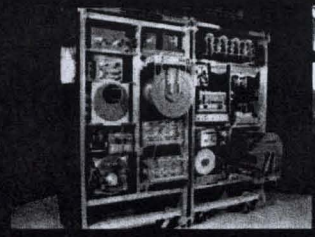
Down-to-Earth Benefits from the Space Economy

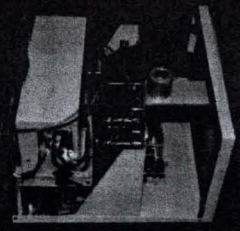
NASA

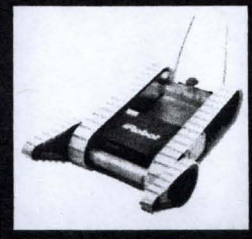
NASA powers innovation that creates new jobs, new markets, and new technologies

- **Personal Health**
  - Eye tracker for LASIK surgery
  - Breast biopsy system
  - 3D Imaging for surgery
- **Consumer Products**
  - Wireless light switch
  - Remote appliance programmer
  - Global Positioning Systems (GPS)
- **Environmental**
  - Water Filtration system
  - Environmentally friendly chemical cleanup
- **Security**
  - Stair-climbing tactical robot
  - Crime scene video enhancement









For more information see http://technology.jsc.nasa.gov

Every Dollar Invested in Space is Spent on Earth

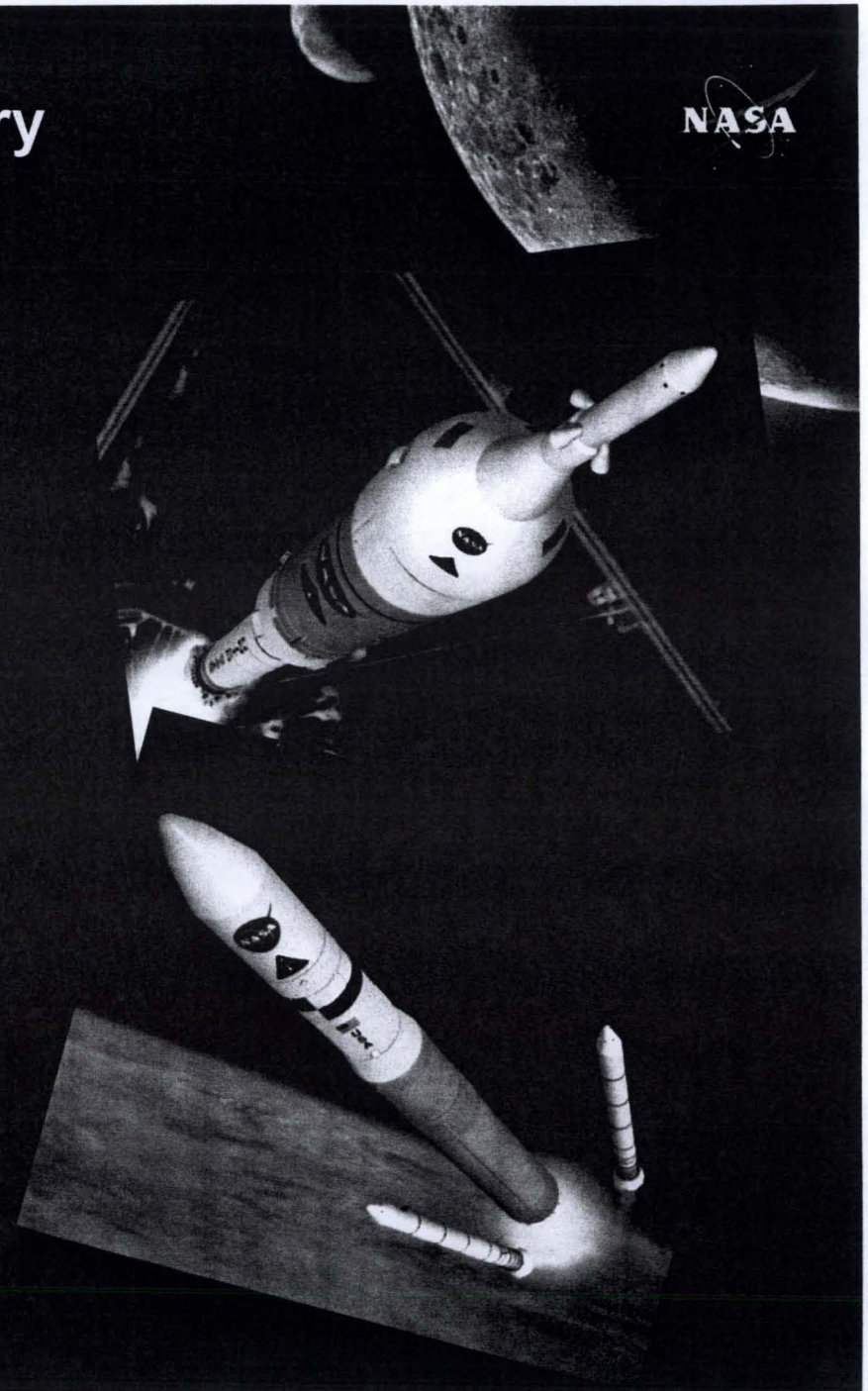
NASA Explores for Answers that Power Our Future

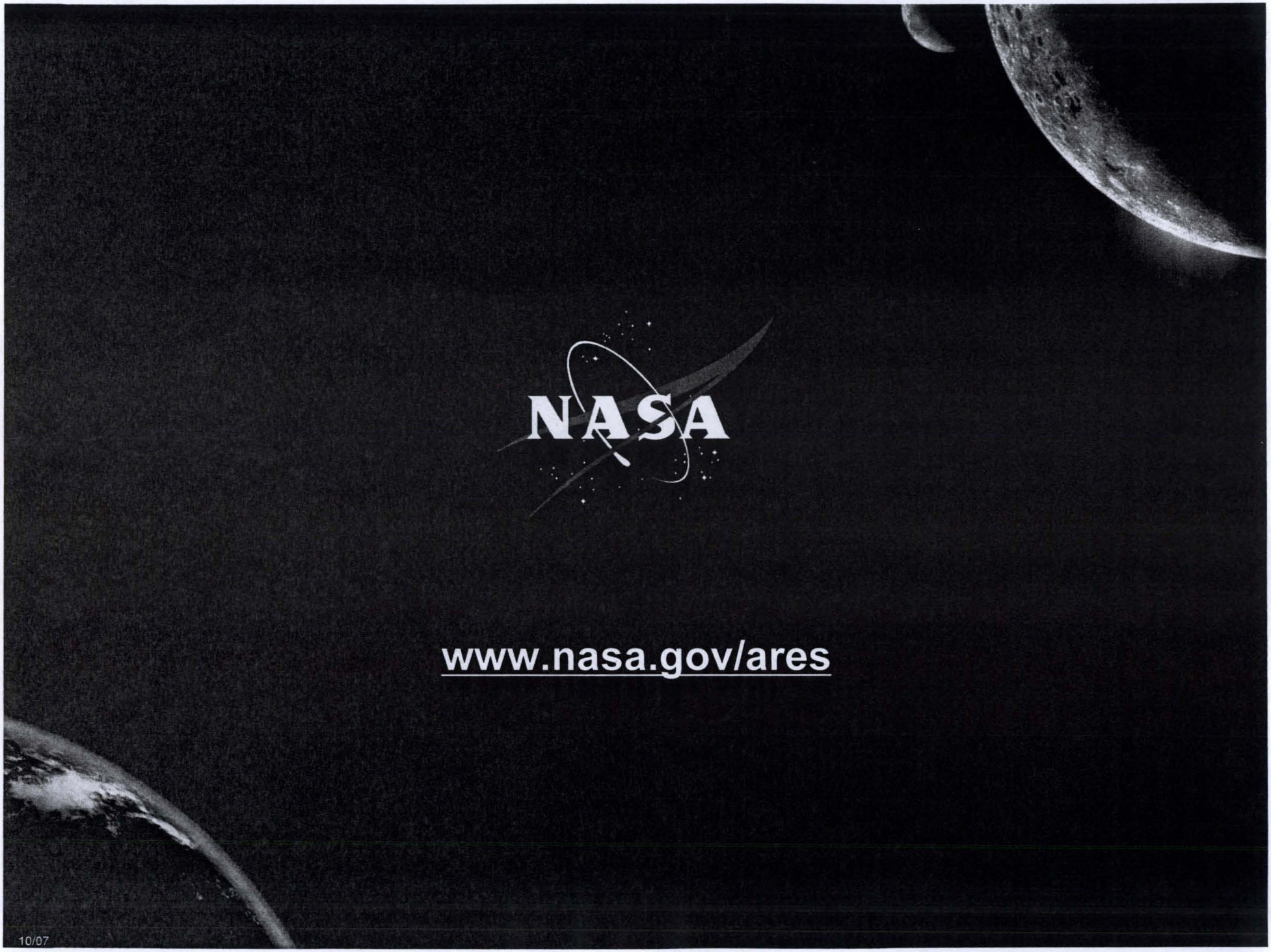
NASA powers inspiration that encourages future generations to explore, learn, and build a better future

- **NASA relies on a well-educated U.S. workforce to carry out missions of scientific discovery that improve life on Earth**
- **America's technological edge is diminishing**
  - Fewer engineering graduates from U.S. colleges and universities
  - More engineering and science graduates in other countries
- **Global marketplace is increasingly competitive and technology-driven**
- **Students need motivating goals and teachers with information to share**
- **NASA continues to develop educational tools and experiences that inspire, educate, and motivate**

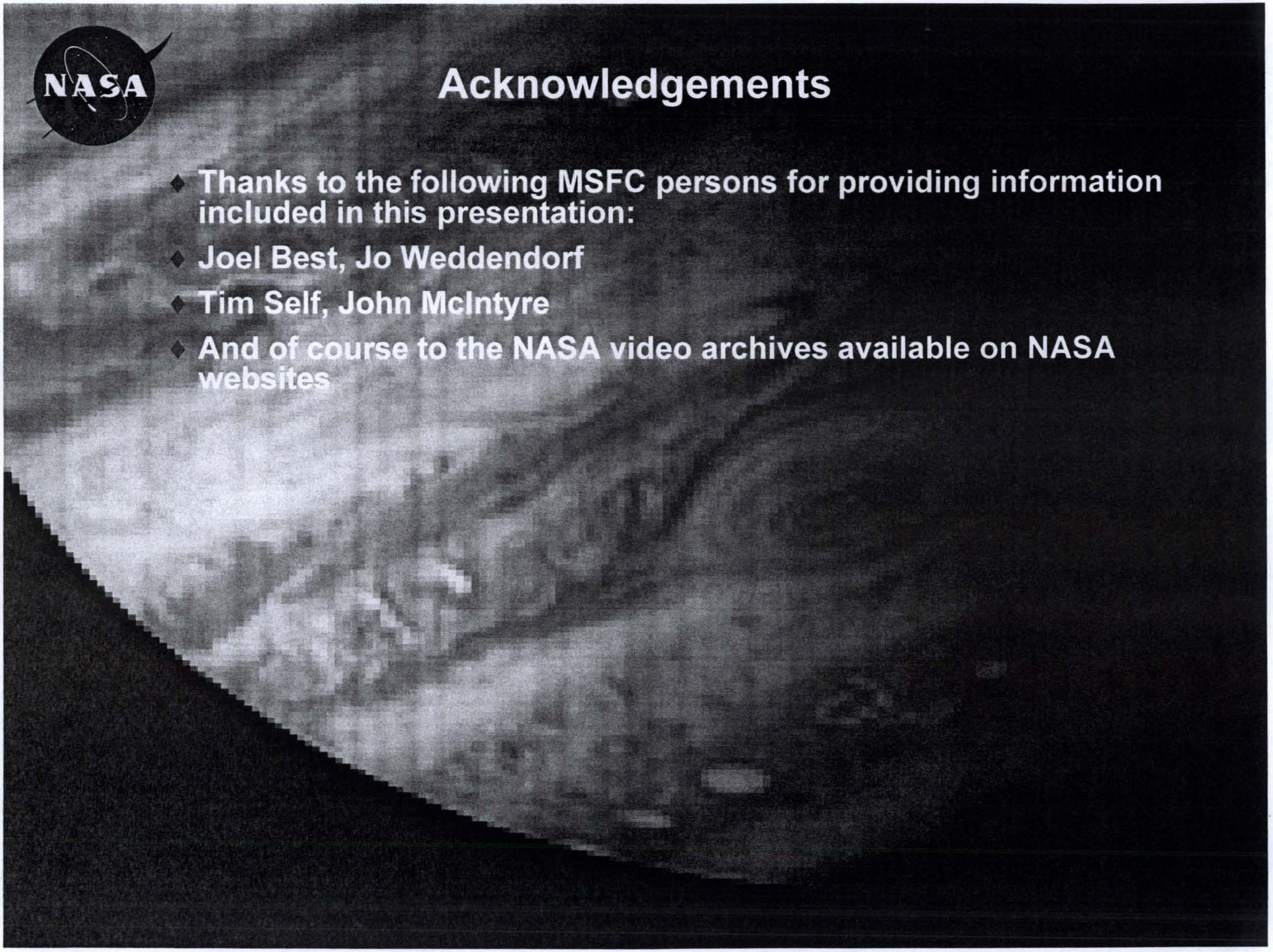
Summary

- Human beings will explore the Moon, Mars, and beyond to encourage inspiration, innovation, and discovery.
- We must build beyond our current capability to ferry astronauts and cargo to low Earth orbit.
- We are starting to design and build new vehicles, using extensive lessons learned to minimize cost, technical, and schedule risks.
- Exploring the Moon will help us reach Mars and beyond.
- Team is on board and making good progress – the Ares I-X test flight is on schedule for April 2009.





www.nasa.gov/ares



Acknowledgements

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- And of course to the NASA video archives available on NASA websites